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THERMOSTRUCTURAL ANALYSIS OF STRUCTURAL PLATES

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ABSTRACT

This paper aims the evaluation of the thermal réponses, stresses, deformations and frequencies for Structural Steel and Aluminum. Thermal, Static, Modal and Random vibration analysis are performed on the plates for Structural Steel and Aluminum using Solid Element. The modeling of the plate has been carried out, as per the required dimensions for all the selected materials to all the cases. The analysis of the results has been compared with all the selected materials, in all the cases.

KEYWORDS: Thermal analysis, Equivalent stress, Equivalent strain, Frequencies & Total deformation

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Original Article

INTRODUCTION

The research areas are focusing to identify the future materials, with the help of solving the analysis for present materials. This research work is focused on behavior of material for the given boundary conditions, with the specified geometry for all conditions.

MODELING OF PLATES

The modeling of plate has been done as per the required geometry.

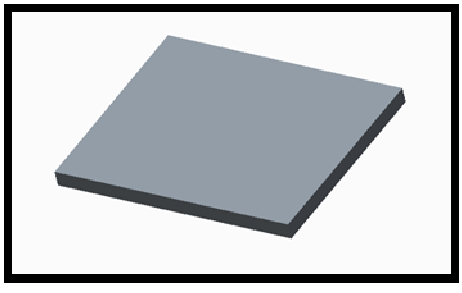

Figure 1: 3D Model of Structural Plate

For modeling of plate, the following dimensions have been taken.

Plate length: 500 mm

Plate width: 500 mm

Plate thickness: 60 mm

MESHING AND BOUNDARY CONDITIONS

For the dévelopments of thermo structural analysis, meshing and boundary conditions should be given. The structural plate has been analyzed, for pressure 20 MPa. The figure.2, shows the meshed model of structural plate.

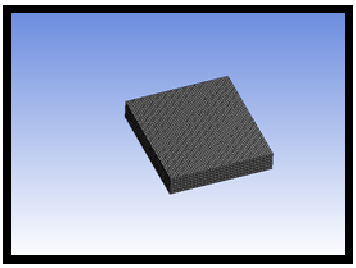

Figure.2: Meshed Model of Plate

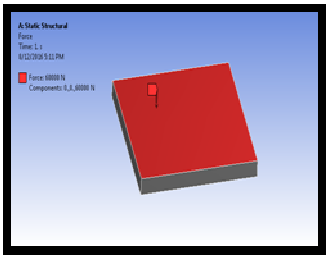

Figure.3: Force Applied on the Plate

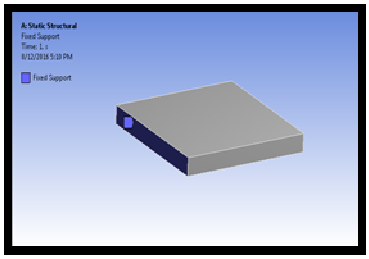

Figure.4: Fixed Support Applied Contour

Table.1: Material Properties

MATERIAL	Density (g/cc)	Young's Modulus(GPa)	Poisson's ratio	Allowable Strength (MPa)
STRUCTURAL STEEL	7.87	200	0.26	275
ALUMINUM	2.6989	68.0	0.36	310.26

The table.1, shows the material properties of the structural steel and aluminium material.

FORCE CALCULATIONS

Pressure value taken as 20 Mpa

$P = F/A$;

P → Pressure ;F→ Force ;

A→ Area ;

$F = P \times A$;$F = 20\ N/mm^2 \times (500 \times 60)\ mm^2$

$F = 120 \times 500 = F = 60000\ N$

STRUCTURAL ANALYSIS OF PLATE

The structural analysis of plate has been carried out for the given materials, by applying the given boundary conditions for selected geometry of the plate.

MATERIAL – STRUCTURAL STEEL

The structural analysis has been carried out for the selected steel material, with the selected boundary conditions.

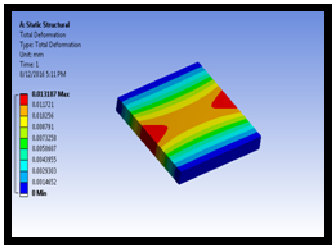

Figure.5: Total Deformation

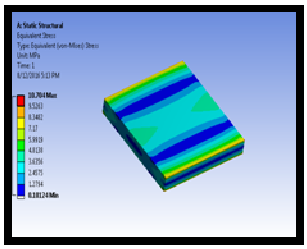

Figure.6: Equivalent Stress

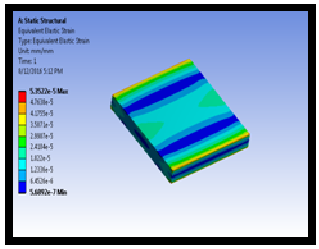

Figure.7: Equivalent Elasticstrain

MATERIAL- ALUMINUM

The structural analysis has been carried out for the selected Aluminium material, with the selected boundary conditions.

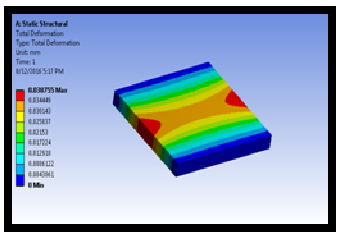

Figure.8: Total Deformation

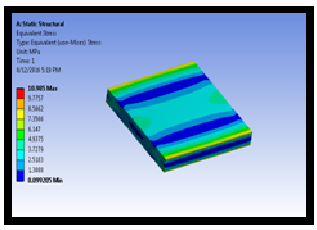

Figure.9: Equivalent Stress

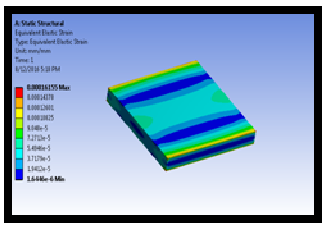

Figure.10: Equivalent Elastic Strain

MODAL ANALYSIS OF PLATE

The modelling of the plate has been carried out, as per the required specifications.

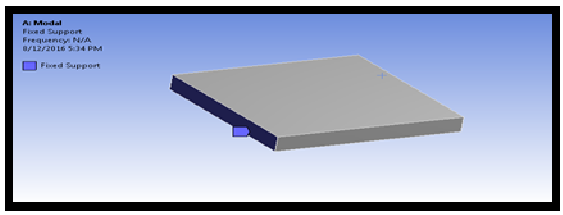

Figure.11: Boundary Conditions for Modal Analysis of Plate

MATERIAL -STRUCTURAL STEEL

The Modal analysis has been carried out for the selected steel material, with the selected boundary conditions.

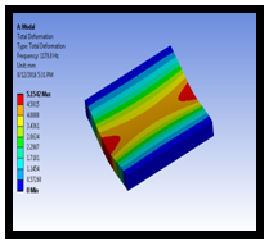

Figure.12:Total Deformationat Mode 1

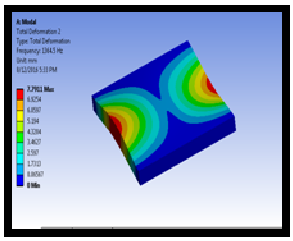

Figure.13:Total Deformationat Mode 2

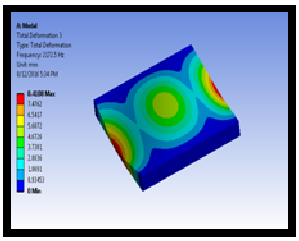

Figure.14:Total Deformationat Mode 3

MATERIAL – ALUMINUM

The Modal analysis has been carried out for the selected Aluminium material, with the selected boundary conditions.

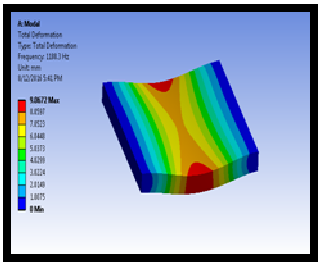

Figure.15: Total Deformationat Mode 1

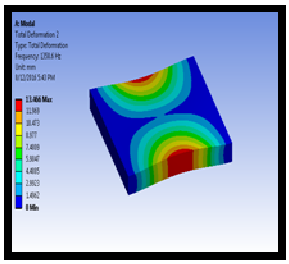

Figure.16: Total Deformationat Mode2

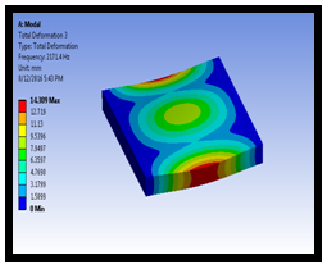

Figure.17: Total Deformationat Mode 3

RANDOM VIBRATION ALANALYSIS OF PLATE

Enter frequencies and deformation values from modal analysis.

Tabular Data

	Frequency [Hz]	Displacement [(mm²)/Hz]
1	1179.8	5.1542
2	1364.5	7.7911
3	2172.5	8.4108

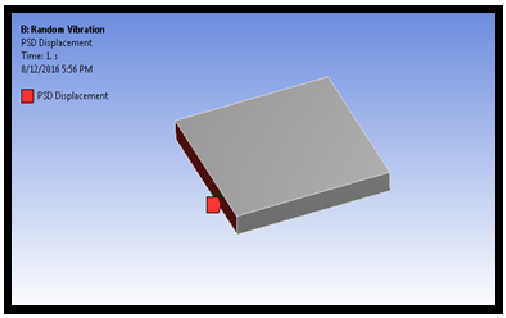

Figure18: Displacement

MATERIAL- STRUCTURAL STEEL

The Vibration analysis has been carried out for the selected steel material, with the selected boundary conditions.

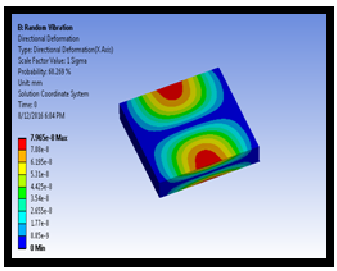

Figure.19: Directional Deformation

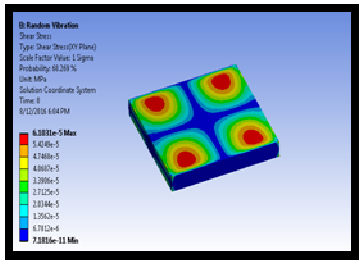

Figure.20: Shear Stress

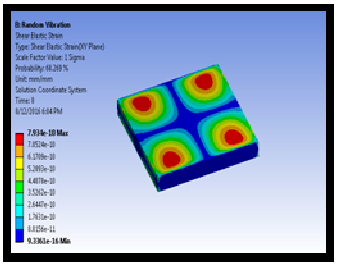

Figure.21: Shear Strain

MATERIAL – ALUMINIUM

The Vibration analysis has been carried out for the selected Aluminium material, with the selected boundary conditions.

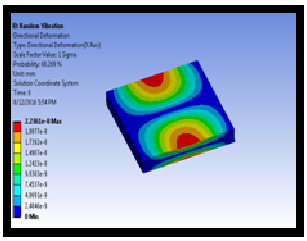

Figure.22: Directional Deformation

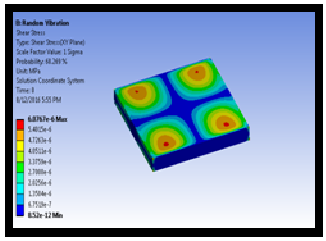

Figure.23: Shear Stress

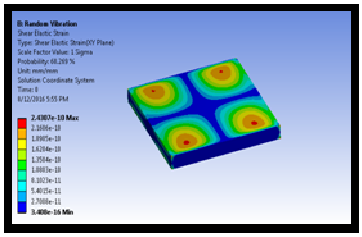

Figure.24: Shear Strain

THERMAL ANALYSIS OF PLATE

The following are the boundary conditions to develop the thermal analysis of the plate.

Enter temperature value 100^0C → Select convection → select required area → click on apply → Enter film coefficient value→ 1000 W/m^2. K

Enter bulktemperature value 22^0C→

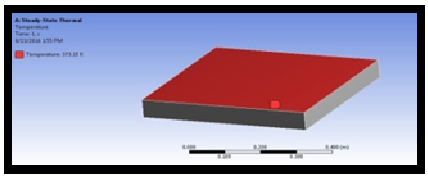

Figure.25: Temperature Contour Plot

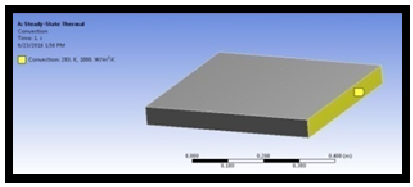

Figure.26: Convection Contour Plot

MATERIAL –STRUCTURAL STEEL

The Thermal analysis has been carried out for the selected steel material, with the selected boundary conditions.

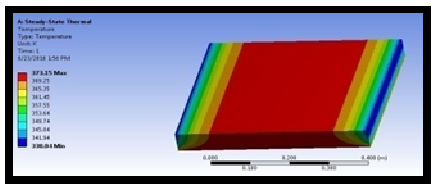

Figure.27: Temperature Distribution

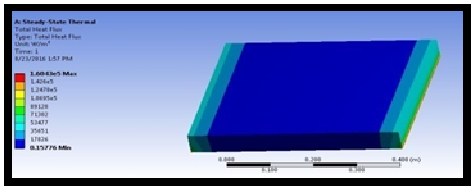

Figure.28: Heat Flux

MATERIAL – ALUMINUM

The Thermal analysis has been carried out for the selected Aluminium material, with the selected boundary conditions.

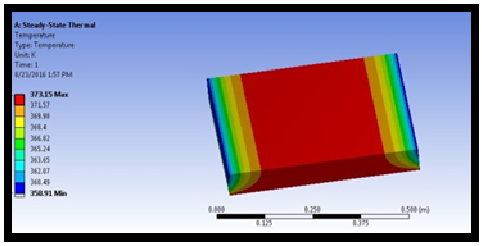

Figure.29: Temperature Distribution

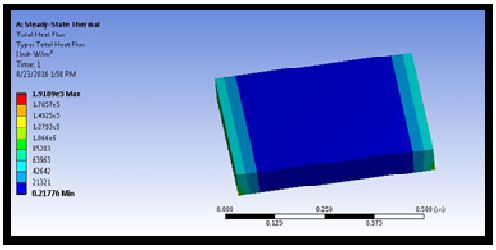

Figure.30: Heat Flux

RESULTS & DISCUSSIONS

After completion of the analysis of the plate the results are tabulated in the tabular column.

STRUCTURAL ANALYSIS

The structural analysis results has been plotted in the table.2

Table.2: Static Analysis Results of Plate

Material	Deformation(mm)	Strain	Stress (Mpa)
Structural steel	0.013187	5.3522e-5	10.704
Aluminum	0.038755	0.00016155	10.985

MODAL ANALYSIS

The Modal analysis results have been plotted in the table.3.

Table.3: Modal Analysis Results of Plate

MATERIAL	MODE 1		MODE 2		MODE 3	
	Deformation (mm)	Frequency (Hz)	Deformation (mm)	Frequency (Hz)	Deformation (mm)	Frequency (Hz)
Structural steel	5.1542	1179.8	7.7911	1364.5	8.4108	2172.5
Aluminum	9.0672	1188.3	13.466	1358.6	14.309	2171.4

RANDOM VIBRATION ANALYSIS

The Vibration analysis results have been plotted in the table.4.

Table.4: Random Vibration Analysis Results of Plate

Material	DirectionalDeformation(mm)	Shear Stress (Mpa)	ShearStrain
Structural steel	7.965e-8	6.1031e-5	7.934e-10
Aluminum	2.2361e-8	6.0767e-6	2.4307e-10

THERMAL ALANALYSIS

The Thermal analysis results have been plotted in the table.5.

Table.5: Thermal Analysis Results of Plate

Material	Temperature	Heat flux (W/mm^2)
Structural steel	373.15	1.6043e5
Aluminum	373.15	1.9189e5

CONCLUSIONS

Thermal, Static, Modal and Random vibration analysis have been performed, on the plates for Structural Steel and Aluminum using Solid Element. By observing the structural analysis results, for deformation values, the values are less, when Aluminum is used compared to Steel. By observing the modal analysis results, for deformation values, the values are less for Aluminum than steel material.

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